A COMPARISON OF BENTHIC INVERTEBRATES IN THE ETOWAH RIVER 1958 & 2018

Jeremy Miller[1], Gabriel Pierce[1], Rachel Pesaresi[1], Rachel Tempia[1], William Teitjen[3], Margi Flood[2]

AFFILIATIONS: [1] Undergraduate student, [2] Associate professor, University of North Georgia, Gainesville Campus, 3820 Mundy Mill Road, Oakwood GA 30566; [3] Emeritus Professor of Biology, Georgia Southwestern State University

REFERENCE: *Proceedings of the 2019 Georgia Water Resources Conference*, held April 16-17, 2019, at the University of Georgia.

Abstract. The Etowah River originates in Lumpkin County northwest of Dahlonega. It flows south then west across North Georgia joining the Oostanaula to form the Coosa River. It is famous for its biodiversity and is home to many threatened and endangered aquatic species. Landscape use in North Georgia has changed in the past 100 years, shifting from agriculture to secondary regrowth of forests to increasingly large pockets of urbanization. This project examines benthic invertebrate composition change over sixty years in a small section of the Etowah. Monthly benthic samples were taken at three locations in the section of the Etowah that abuts Dawson Forest from October 1958 to September 1959. Organisms were identified to the lowest possible level. These were the 'Before' samples for a project to assess radiation impact on the river from an unshielded reactor. The project and the reactor were shut down and the data were stored. We replicated equipment and collection sites from September 2017 to September 2018. Organisms were identified to lowest possible taxa and organic matter was identified and weighed. September and October 2017 samples have been analyzed. There does not seem to be a huge difference in composition which may be due to the fact that the watershed was recovering from heavy agricultural use in the 1950s and has been relatively protected since then. This is changing rapidly with urbanization. Antidotal evidence suggests large quantities of sand have reduced heterogeneity and depth in some areas. The discussion of species loss and baseline shifting is in the news now. Our present day understanding of what is here is very different from what was here. We suggest that the boxes in closets containing field notebooks and old vials be checked to find interesting and important archived data.

INTRODUCTION

Macroinvertebrate biomonitoring is a standard method to assess aquatic health [1]. Organisms are collected, counted and identified to lowest taxon. Various metrics use species number, diversity and tolerance levels to put a quantifiable number on stream health. These metrics are often developed using less impacted reference stream in the region.

We know that altered habitats affect species composition and numbers. Long-term monitoring, >6 years, is one of the best ways to assess changing environmental conditions and community structure. This is not always possible, due to personnel and monetary constraints, which can result in 'snapshot' comparisons [2]. It is also possible that these one-off collections can be involuntary, such as when a grant is pulled and research stops. This does not make the data collected any less useful.

We were presented with a rare opportunity to compare a snapshot collection when one of the co-authors unearthed data collected sixty years ago on the Etowah River.

METHODS

History

The Etowah River originates in Lumpkin County northwest of Dahlonega. It flows south then west across North Georgia joining the Oostanaula to form the Coosa River. The river's watershed has changed dramatically in the last 200 years. The North Georgia mountains have changed from old growth on the ridges and agriculture in the valleys in the early 1800s to subsistence farming with some forest cover to industrialized forestry and loss of farms in the late 1800s to early 1900s [3]. The City of Atlanta tract of Dawson Forest was initially small farms in the early 1900s. Farms were abandoned and sold in the 1930s and 1940s. The land consisted of cleared or abandoned fields and woodlots. By the early 1950s, Dawson Forest was a large, >10,000 acres, continuous tract of land with the Etowah River flowing through the central portion [4]

The US Federal Government, Army Corp of Engineers and the Air Force bought the land in 1956. Lockheed Aircraft Corporation operated the Georgia Nuclear Aircraft Laboratory there from the late 1950s until 1971. The site was decommissioned in 1971 and sold to the City of Atlanta in 1972. The Georgia Forestry Commission started management in 1975. It is now a Wildlife Management Area managed by Georgia DNR Wildlife Resources Division [4].

This history is important because it highlights the possibility of Shifting Baseline Syndrome [5]. The conditions in 1958 were not pristine, but the result of 150 years + of habitat alteration. It would be expected that the community differed from the pristine condition. The 2017-8 collections are therefore being compared to an already altered community.

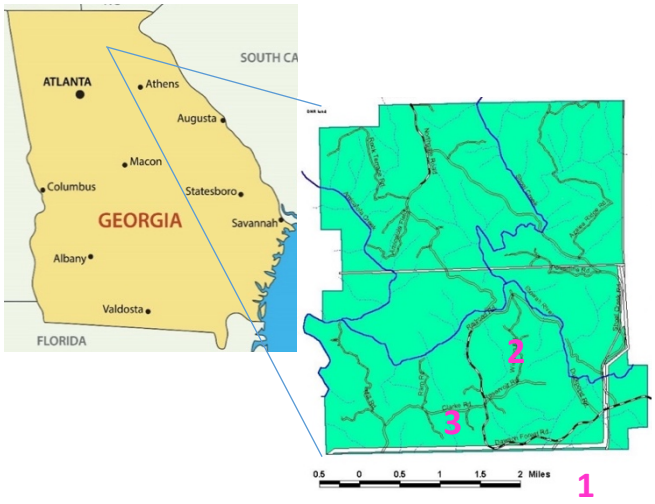

Figure 1. The upper Etowah River with designated collection sites.

Field Collection

The Etowah River is a mid-sized river that historically has had high biodiversity in fishes and mollusks. The sites are located in a WMA with forested banks. Upstream land use is agricultural and more recently urban.

The purpose of the initial yearlong survey in 1958-59 was to get a broad spectrum of ecological information on the effects of radiation exposure on the environment. Three collection sites were established. One Surber sample was collected at each site monthly for a year. We reestablished the three collection locations in September 2017, plus or minus a few hundred meters, with Dr. Teitjen's assistance (Figure 1). Site One, the furthest upstream, is where a railroad bridge crossed the Etowah and is a mix of cobble and sand. Site Two is an equestrian crossing with gravel and small to large cobbles and is near the old reactor location (Figure 2). Site Three is at a small outcrop waterfall with cobble substrate and is the only exact location. All sites had *Podostemum* growing on cobbles.

We collected monthly samples from September 2017 through September 2018 following the 1958 protocol. We took three replicate samples with a Surber sampler at each site. All organic and inorganic matter collected was preserved in 75% ETOH. Especially large cobble or branches were scrubbed into the net and returned to the river. We did not collect in March 2018 due to extremely high water.

Lab Protocol

Samples were sorted using a dissecting scope. Organisms were identified to order and family. Organic matter, primarily *Podostemum*, was air dried and weighed. Inorganic matter, sand, gravel and cobble, was noted and discarded.

The 1958 samples were identified to genus. Our samples have been identified to family currently. We grouped the 1958 samples by family to allow initial comparisons.

Figure 2. Site Two on the Etowah River, September 2017, looking upstream (photo by M. Flood)

Diversity indices will be done when identification is completed to genus. Taxon and total numbers are compared here.

RESULTS AND DISCUSSION

The comparison across 59 years showed a decline in both diversity and total numbers. September numbers in 1959 were 10X greater than the 2017 collections. The 2017 collections at each site are combined, so that numbers reflect 3X the area sampled in 1958 or 1959. (Tables 1 and 2.)

Total numbers vary greatly and were influenced by a few families. Hydropsychiidae, Brachycentridae, Elimidae and Simuliidae were most numerous and could dramatically increase total numbers in one collection. Substrate was important in which taxa were found. One genus of Brachycentridae was extremely abundant when *Podostemum* was present. Based on discussions with Dr. Teitjen, we feel that the substrate is comparable among years although there has been significant deposition of sand into the river. This was most evident at the third site, the waterfall. Corbicula was found in the 2017 collections. It was first collected in Georgia in 1971 [8]

Our data suggest change in abundance and diversity of species is due largely to habitat degradation. The landscape of Dawson Forest has changed from small farms and woody areas, to much larger farms and recreation areas, with more roads and trails available to the public. We currently do not have any abiotic measurements of water quality from 1958 and 1959, but the higher abundance of high tolerance organisms suggests supports degradation of water quality over the years.

One of the goals of future research is to compare 1958 and 1959 land use to the current land use of Dawson Forest and upstream, giving insights into the reasons for such a dramatic drop in moderately tolerant organisms. Land upstream from our sites is converting from farms and woodlots to higher density suburban and commercial uses. This highlights the importance of data that can connect the effect of the land on the quality of the water. Records don't show that any of the collection years experienced drought, but an investigation into the average temperature and rainfall will be obtained in hopes of more evidence to support our data.

Studies on the Rhone River and the rivers in NY suggest a worldwide long-term trend on the effect of habitat change on aquatic invertebrates [6,7]. Our data, although separated with larger time gaps between collections, follows these same long-term trends. Not all samples have been separated and identified through September of 2018, but plans are in place to continue this through the next year. We plan to identify to genus and species where possible. This will allow us to compare the over-all species diversity from 1958 to 2018.

LITERATURE CITED

1. Karr, J. 1987. Biological monitoring and environmental Assessment: a conceptual framework. Environmental Management 11 (2):249-256.
2. Huttunen, KL, H Mykra, R Paavola, T Muota 2018. Estimates of benthic invertebrate community variability and its environmental determinants differ between snapshot and trajectory designs. Freshwater Science 37(4):769-779.
3. Martin B 2003. Forest removal in the Georgia mountains New Georgia Encyclopedia accesses 9 April 2019
4. McClure N. Dawson Forest, City of AtlantaTtract. Then and Now. Phamplet.
5. Guerrero-Gatica M, E Aliste, J Simonetti. 2019. Shifting gears for the use of the Shifting Baseline Syndrome in ecological restoration. Sustainability 11:1458. 1-12
6. Smith, A, Duffy B. 2018. Long-term trends in biological indicators and water quality in rivers and streams of New York State (1972-2012): water quality trends in New York State. Researchgate.
7. Fruget, J.-F., C. Jézéquel, G. Archambaud, J. Dessaix and M.-C. Roger, 2015. Long-term effects of global and local changes on benthic macroinvertebrate communities in multistressed large rivers: the example of the Rhône River during the last 30 years. Knowl. Manag. Aquat. Ecosyst., 416, 29
8. Asian Clam (*Corbicula fluminea*) Ecological Risk Screening Summary. U.S. Fish & Wildlife Service February 2011. Reviewed, September 2014 and July 2015.

Table 1. Identification and abundance for September 1959 and 2017. All three samples for each site for 2017 are combined. Sites are listed left to right as 1, 2, & 3. Most genera from 1959 raised to family to make for easier reading.

	1959	2017-all	1959	2017-all	1959	2017-all
Annelida	50	2	17	1	7	41
Bivalve Corbicula		8		10		5
Gastropoda	24	5	19	13	40	32
Hydracarina						
Sperchon sp.	24		17		32	
Ephemeroptera						
Neoephemeridae						2
Ephemerellidae					11	1
Isonychiidae	1	2				
Baetidae				1	57	4
Leptohyphidae						2
Heptageniidae		8	17			2
Isonychiidae						
Odonata						
Gomphidae						1
Aeshna sp					1	
Plecoptera						
Plecopters, misc.				1		1
Pteronarcyidae	2				2	
Peltoperlidae				5		
Taenioptery sp.						
Acroneuria sp.			18		31	
Megaloptera						
Corydalus sp		1	1	1	4	4
Trichoptera						
Glossosomatidae						
Rhyacophilidae		5				
Hydropsychidae			178	2	146	2
Leptoceridae					10	
Brachycentrus 1		17	32	58	1	4
Brachycentrus 2			20	1	32	3
Coleoptera						
Elmidae adult			17	3	68	5
Elmidae larva				17	498	23
Psephenus harricki larva			1		12	
Diptera						
Tipulidae		1	1	2	1	
Simulium sp. larva		87	748	8	154	2
Simulium sp. pupa		107	1	1		5
Empididae						
Atherix sp	12	1				
Tabanidae						
Chironomidae	72	2	68	8	178	19
Misc.					6	2
Total #	185	246	1155	132	1291	160

Table 2. Identification and abundance for October 1958, 1959 and 2017. All 3 samples for each site for 2017 are combined. Sites are listed left to right as 1, 2, & 3. There was no 1958 or 1959 collection at site 1. Most genera from 1958 & 1959 raised to family to make for easier reading.

	1958	1959	2017-2-all	1958	2017-3-all
Annelida	3		4		
Bivalve *Corbicula*			9		1
Gastropoda	1		13	9	72
Hydracarina					
Sperchon sp.	7	16			
Ephemeroptera					
Neoephemeridae					
Ephemerellidae	1				8
Isonychiidae					4
Baetidae	6		1		3
Heptageniidae	6	1		1	4
Isonychiidae				1	
Odonata					
Gomphidae					
Aeshna sp					
Plecoptera			1		
Plecopters, misc.					4
Pteronarcyidae			2	2	
Taenioptery sp.	1				
Acroneuria sp.	1				
Megaloptera					
Corydalus sp	1		2		2
Trichoptera					
Glossosomatidae					
Rhyacophilidae	1				
Hydropsychidae	169	16	17	2	10
Leptoceridae	1				
Brachycentrus 1	5		238		4
Brachycentrus 2					
Coleoptera					
Elmidae adult	18	16	1	14	2
Elmidae larva	12		42		33
Psephenus harricki larva	1			2	
Diptera					
Tipulidae	3		1	1	3
Simulium sp. larva	474	48	6		
Simulium sp. pupa	21		1	1	
Empididae	1				
Atherix sp					
Tabanidae					1
Chironomidae	25	64	19		34
Misc.					
Total #	758	161	758	33	185